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ETHANOL

World ethanol production is expected to exceed 15 billion imperial gallons (Ggal) by 2007, as the ethanol industry continues to experience double digit growth. Much of that growth has been in the United States (U.S.) where about 100 plants are now in operation and another 50 plants are either in the planning or construction stage. With that pace of expansion, the U.S. is soon expected to surpass Brazil as the leading producer of ethanol. Canada also has plans to reduce its reliance on fossil fuels and lower green house gases by expanding ethanol production, albeit on a much smaller scale. This issue of the *Bi-weekly Bulletin* examines the ethanol industry and looks at the implications for Canada's grains and oilseeds sector. For information on biodiesel, please refer to *Bi-weekly Bulletin*, *Volume 19 Number 15*, entitled "Biodiesel".

Background

Between 2004 and 2005, world ethanol production grew by nearly 10%, to 11.8 Ggal or 44.7 billion litres (GL). The growth in the renewable fuels industry is being driven largely by the need for a reliable source of energy. This is particularly the case for the U.S., which is highly reliant on foreign sources of crude oil.

Concerns for the environment are also a major concern. Ethanol is seen as a logical replacement for Methyl Tertiary Butyl Ether (MTBE) which, as an oxygenate, improves combustion in gasoline engines and allows fuel to burn cleaner. However, MTBE has long been known to contaminate ground water, even in the case of small spills.

There are additional economic benefits to be derived from expanded ethanol production. In particular, ethanol from corn and cellulose is being seen as a means of propping up the agricultural sector which experiences, from time to time, low commodity prices.

Currently, more than 60% of the world's ethanol is produced from sugar. That production is concentrated in Brazil where an abundance of sugar cane has allowed Brazil to become a world leader in ethanol production.

However, Brazil's dominance in world ethanol production is being challenged by the U.S. where production of corn-based ethanol is increasing rapidly and research into cellulose-based ethanol holds even greater promise for the future of the renewable fuels industry. In total, Brazil and the U.S. produce about 70% of the world's ethanol, followed by China, India and France with about 9%, 4% and 2%, respectively.

The Ethanol Futures Market

Futures contracts for fuel ethanol are traded at the Chicago Board of Trade (CBoT), and the contracts are available for all calendar months. The size of the ethanol futures contract is 29,000 U.S. gallons, which is approximately the capacity of one tanker railcar. The daily price limit on the ethanol futures contract is US$0.30 per gallon (/gal), or US$8,700 per contract. The CBoT futures contract for fuel ethanol is recognized as the ideal mechanism for accurate and timely price discovery because it is based on actual and verifiable transactions. Ethanol futures are also traded on the New York Stock Exchange.

In June 2006, a record 690 futures contracts were traded at the CBoT, up from 330 contracts in May 2006, and 145 contracts in June 2005. During that record breaking period, nearby futures prices peaked at US$4.20/gal, and the basis hit a record US$2.20/gal. Ethanol futures prices have since tapered off considerably, and the basis has narrowed. Currently, the nearby futures price for fuel ethanol is US$1.72/gal.

The Efficiency of Ethanol Production

The efficiency of ethanol production has long been questioned. Critics would argue that the industry could not survive without government subsidies and that it takes more energy to produce a unit of ethanol than the energy derived from the ethanol. There might have been some merit to these arguments, given the technology that existed at the time, both in terms of agronomic practices and the processes for turning feedstocks into fuel ethanol.

However, a study published in July 2006 by the University of Minnesota concluded that there is a net energy gain with the production of ethanol from corn. Researchers tracked the amount of energy used to grow corn and to turn it into ethanol, and they factored in the cost of transporting the raw product to the plant. Researchers also factored in the cost of how much fertilizer and pesticides were required to grow the corn, and the greenhouse gases, nitrogen, phosphorus, and pesticide pollutants that were released into the environment. They concluded that corn-based ethanol yielded 25% more energy than was expended in producing that unit of ethanol.

The cost of producing ethanol varies with the feedstock being used and its availability. In the U.S. and Canada, corn is the most widely used feedstock because it is generally the cheapest, both in terms of the cost of feedstock and the processing costs. In Brazil, sugar cane is the most cost effective feedstock, despite the relatively low ethanol conversion factor. The low cost of sugar cane and the associated processing costs make Brazil's ethanol producers very competitive in the world ethanol market.

Processing costs, for corn-based ethanol production, depend on the type of milling process. For very large plants, the economics of production favour the wet milling process, despite a lower conversion rate than the dry milling process and higher processing costs per gallon. The value of by-products derived from wet milling more than offsets the lower conversion rate and higher processing costs, resulting in the lower cost per gallon of ethanol. The by-products of the wet milling process are normally corn oil, corn gluten meal, corn gluten feed, and carbon dioxide, but some larger plants have developed the ability to also produce vitamins, food and feed additives from the same feedstock, by-products which help to reduce the cost per gallon of ethanol.

Dry milling accounts for most of the ethanol produced in the U.S., and the main by-products of this process are distillers dried grain with soluble (DDGS), condensed syrup, and carbon dioxide. DDGS is a high-protein feed ingredient, but it is low in amino acids, including lysine. The low levels of lysine limit the usefulness of DDGS in hog and poultry rations. However, the abundance of DDGS in the U.S Midwest, where ethanol plants are concentrated, allows nutritionists to incorporate this relatively low cost feed ingredient into feed rations, provided that the customers for the DDGS are within a certain radius of the ethanol plants.

Currently, the U.S. ethanol industry appears to be less dependent on government subsidies than in the past. That move to self-sufficiency can be attributed to several factors, including record high prices for crude oil. High crude oil prices and the market price of ethanol have made its production much more profitable. In fact, ethanol production might be profitable enough to allow producers to operate without the US$0.50/gal subsidy they currently receive from the U.S. government.

Sustainability of U.S. Ethanol Production

To encourage ethanol production, U.S. Congress has passed legislation that provides subsidies to ethanol producers and mandates oil companies to blend at least 4 Ggal of ethanol with gasoline annually. Furthermore, ethanol retail prices have been closely following gasoline prices in recent months, and boosting profits beyond expectations.

However, the ethanol market might be overheated. For example, a California company in the midst of constructing several ethanol plants, but still not operating, saw its stock prices quadruple over a period of five months.

Investors have experienced attractive returns in recent months, but share prices appear to have peaked as the supply of ethanol has begun to catch up with the strong demand experienced in recent months. Nevertheless, with the current cost of production of corn ethanol estimated at about US$1.10/gal and a government subsidy of US$0.50/gal, the net cost of ethanol to producers is US$0.60/gal, which is considerably less than the Chicago futures price of US$1.75/gal for the December contract. This provides some support for those who contend that the ethanol industry can be sustained without the government subsidies that expire in 2010.

In the U.S., ethanol is made almost exclusively from corn, and Iowa is the leading producer. Currently, 4.8 Ggal of ethanol is produced

ETHANOL: CONVERSION FACTORS AND PRICE PER U.S. GALLON

	Conversion Factor	Feedstocks Costs [1]	Processing Costs	Cost of Ethanol
	gallons per tonne	.....per gallon [2].....		US$
U.S. Corn (wet	94.94	$0.40	$0.63	$1.03
U.S. Corn (dry milling)	98.52	$0.53	$0.52	$1.05
U.S. Sugar Cane	19.50	$1.48	$0.92	$2.40
Brazil Sugar Cane	19.50	$0.30	$0.51	$0.81

[1] feedstock costs for corn wet and dry milling are net of by-products of distillation
[2] price per gallon excludes capital costs

Source: USDA "The Economic Feasibility of Ethanol Production from Sugar in the United States"

annually in the U.S., using about 16% of the U.S. corn crop. Still, ethanol makes up only 3% of U.S. annual gasoline consumption, highlighting the limited ability of corn ethanol to reduce U.S. reliance on crude oil imports. If the entire 10.7 billion bushels (Gbu) of corn that the U.S produces annually were to be used in ethanol production, this would displace about 20% of the total gasoline consumed in the U.S. each year.

Technological advances have improved the efficiency of ethanol production from traditional feedstocks. A recent example is the new method of producing ethanol from corn developed by food science researchers at Purdue University. This new method produces about 2.85 gallons per bushel of corn, slightly higher than current methods. Another benefit of the new method is the biodegradable by-products that are safe to eat. Researchers used machinery originally designed to make plastics to grind the corn and to liquefy the starch with high temperatures. This reduced the amount of water normally used in the wet milling process by about 90%, and electricity use was reduced by almost 50%.

Ethanol from Plant Cellulose

According to industry estimates, producing more than 30 Ggal of ethanol from U.S. corn would seriously disrupt feed and food markets. With that in mind, alternative feedstocks are being considered for increasing ethanol production. Based on pilot operations in Canada and the U.S., the office of the U.S. Energy Secretary predicts that converting crop waste and prairie grasses into ethanol could be economically and financially feasible within five years.

Government and private sector scientists have been working for years on ways of reducing the cost of producing ethanol from cellulosic material. Researchers at the University of Nebraska-Lincoln pegged the cost of cellulosic ethanol in 1982 at US$3.60/gal. The ultimate goal is to bring down the cost of cellulose ethanol to the same level as corn ethanol, or about US$1.10/gal, but US$1.50/gal appears to be a more realistic goal in the medium-term. A limiting factor for the production of cellulosic ethanol is the amount of feedstock, within a 60 mile radius, needed to maintain an efficiently sized plant producing 100 Mgal of ethanol annually.

Ethanol produced from switchgrass, mixed prairie grasses and woody plants grown on marginal land could potentially meet the growing demand for fuel. There may even be some added economic benefits from developing the cellulosic ethanol market, in particular, increasing employment for rural communities.

There is currently no commercial production of ethanol from cellulose, although the first commercial plant is being planned in Spain. A U.S. firm recently announced plans to convert their conventional dry milling facility in Emmetsburg, Iowa to the production of ethanol from cellulosic material. This would be the first commercial-sized cellulosic ethanol plant in the U.S. and it would use the stalks, leaves and cobs from corn, as well as grain corn, to produce ethanol. Once fully operational, the Emmetsburg plant would produce about 125 MGal of ethanol annually.

Ethanol Production in Canada

In Canada, the economics of ethanol production are similar to those in the U.S., but there are some differences. The U.S. is heavily reliant on foreign sources of crude oil and it imports twice as much crude oil as it produces in order to meet its annual energy needs. Canada, on the other hand, is self-sufficient in most energy sources, including crude oil.

Canada is a net exporter of energy, most of which goes to the U.S. However, Canadian consumers pay a world price for vehicle fuel, which provides an incentive to conserve non-renewable energy sources and to develop alternative forms of energy.

The Canadian government initiated the Ethanol Expansion Program (EEP) in August 2003 as

CANADA: ETHANOL PRODUCTION

		Annual Output (ML)	Feedstocks Required (Mt)	DDGS Produced (Mt)
WHEAT-BASED ETHANOL				
Company	**Location**			
API Grain	Red Deer, AB	26	0.07	0.02
Husky Energy Inc.	Lloydminster, SK	130	0.33	0.10
Husky Energy Inc.	Minnedosa, MB	10	0.03	0.01
Pound-Maker Agventures	Lanigan, SK	12	0.03	0.01
Sub-Total		**178**	**0.46**	**0.14**
CORN-BASED ETHANOL				
Company	**Location**			
GreenField Ethanol Inc.	Tiverton, ON	26	0.06	0.02
GreenField Ethanol Inc.	Chatham, ON	187	0.46	0.14
Suncor Energy	Sarnia, ON	208	0.52	0.16
Sub-Total		**421**	**1.04**	**0.32**
Total		**599**	**1.50**	**0.47**
	with Varennes construction	*719*	*1.81*	*0.56*
	with Minnedosa expansion	*839*	*2.14*	*0.66*
	Target for 2010	**2,740**	**6.86**	**2.13**

Source: Canadian Renewable Fuels Association

part of their strategy to deal with climate change. The EEP provides capital assistance for plant construction and upgrades. The Canadian government has also committed to a 5% average renewable content requirement in Canadian transportation fuel by 2010. An allocation of CAN$118 million allows for a federal excise tax exemption of CAN$0.10 per litre, support for research and development, and consumer awareness activities.

With the incentives in place, the Canadian government projects that ethanol production will increase to about 2.74 GL by the end of 2010. Current ethanol production in Canada is estimated at 0.60 GL, but once the GreenField Ethanol Inc. and Husky Energy Inc. plants are fully operational in 2007, total ethanol production in Canada is expected to be about 0.84 GL.

In addition to the federal initiatives, several Canadian provinces are providing varying levels of road tax exemptions for ethanol-blended fuels and some have mandatory blending rates to encourage increased ethanol production. For example, the mandates for Manitoba, Saskatchewan, and Ontario are 8.5%, 7.5% and 5%, respectively.

Prospects for the North American Ethanol Industry

Industry analysts predict that U.S. ethanol supplies could increase by more than 90% by the end of 2008. A surge in ethanol production of that magnitude is expected to pressure prices and to reduce the profitability of some ethanol plants. Increased competition for feedstocks and the logistics of shipping ethanol to the main gasoline markets would further exacerbate the bottom line for ethanol producers.

On that basis, one large U.S. firm is taking a cautious approach in dealing with the recent ethanol boom. Unlike Archer Daniels Midland (ADM), which is planning to increase its current 1.1 Ggal capacity by 50%, Cargill is limiting its investment in ethanol plants and focusing on serving the firms that already operate ethanol plants. The rationale for this cautionary approach is that ethanol's profitability is highly dependent on government subsidies and mandates which could change under different governments. Furthermore, the primary inputs for ethanol production, corn and natural gas, can be subject to prices swings, similar to those for crude oil.

Implications for Canada's Agricultural Sector

Corn is currently the most important feedstock for ethanol production in Canada, just as it is in the U.S. However, that is changing with the increased expansion of ethanol production in western Canada where wheat is the primary feedstock. It is typically lower grades of wheat, (i.e., those that do not meet the higher standards required of milling wheat) that provide the main feedstock for ethanol production in western Canada. As Canada's ethanol industry continues to grow, Canadian farmers will be looking to incorporate higher yielding wheat varieties into their crop rotations, and plant breeders will be focused on developing higher yielding varieties of wheat for the non-milling market.

Currently, about 1.0 Mt of corn and 0.5 Mt of wheat are used to produce 0.6 GL of ethanol annually in Canada. The annual production of ethanol yields about 0.3 Mt of DDGS. Assuming that Canada meets it production target of 2.74 GL of ethanol by the year 2010, approximately 4.6 Mt of corn and 2.3 Mt of wheat will be required, which in turn will yield about 2.1 Mt of DDGS.

Regardless of how much corn and wheat Canadian farmers choose to produce for the fuel ethanol market, or canola and soybeans for the biodiesel market, increased supplies of DDGS and protein meal will have an affect on the animal feed market. However, it is too early to determine with any accuracy what effect future expansions in the biofuels sector will have on the human food market, as biofuels compete for limited resources.

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